

White Paper Report

Report ID: 107094

Application Number: PF-50256-12

Project Director: Lois Hamill (hamilll1@nku.edu)

Institution: Northern Kentucky University W. Frank Steely Library

Reporting Period: 10/1/2012-6/30/2014

Report Due: 9/30/2014

Date Submitted: 9/30/2014

White Paper
PF-50256-12

W. Frank Steely Library Special Collections &
Archives Sustainable Preservation Environment
Planning Project

Lois Hamill, Project Director
Northern Kentucky University, W. Frank Steely
Library
Sept 29, 2014

Project Activities

In 2012, the Eva G. Farris Special Collections and Schlachter University Archives (SC&UA) department of the W. Frank Steely Library at Northern Kentucky University (NKU) was awarded a National Endowment for the Humanities *Sustainable Cultural Heritage Collections* planning grant of \$40,000 plus an additional \$10,000. The purpose of this award was to study and evaluate the existing environment in the archives, including the environmental conditions, equipment settings and operational practices; assess the risk of damage to the collections; and determine what changes were necessary to create a sustainable, preservation environment that would provide long term safety for collections and where possible to also be energy efficient. The additional \$10,000 was for work to be accomplished during the grant leading to improvements.

The project team formed during the grant writing phase came together at the first site visit by the Image Permanence Institute's (IPI) Senior Preservation Environment Specialist Jeremy Linden Oct 23-25, 2012. Engineer Tag Foster of Staggs and Fisher Consulting Engineers, Inc. also attended. Due to staff turnover and changes in job assignments, Rob Knarr from the NKU University Architect's Office replaced Mary Lee Schott. The fact that Rob is an engineer and had project management skills made him a strong addition to the team. It was helpful to have someone who could provide a second opinion on technical questions. I informed my Program Officer of the personnel changes.

During site visit #1, the whole team was finally able to meet face to face to discuss the project, anticipated activities, each person's role and project goals as they then stood. Jeremy Linden spoke briefly about recent research regarding relative humidity and temperature and its implications for preservation of archival materials. Linden, Project Director Lois Hamill and team member Bob Fox (the HVAC shop supervisor) toured air handler unit #1a[AHU#1a], the mechanical system serving SC&UA. Linden discussed system details with Fox and reviewed blueprints. Working with HVAC mechanic Kenneth French, Linden placed 20 PEM recording environmental monitors throughout the mechanical system, all rooms used by SC&UA [first floor], a representative location in Knowledge Management [second floor] also serviced by AHU#1a, and in first and second floor ducts served by AHU#1a to monitor incoming and return [outgoing] air. One monitor was placed to track the outside temperature and relative humidity. Three HOBO amp data loggers, which measure energy consumption, were placed at the supply and return air fans and the supplemental chiller.

Team members set up accounts for and were trained on the software used to view the monthly PEM readings. Initial readings were taken to confirm all monitors were functional. All PEM monitors were checked at the two week mark to confirm continued functionality. They were read again thereafter on a monthly cycle at the beginning of each month for the duration of the grant project. Energy monitors were only read at the time of site visits as NKU personnel didn't have the software required to read them.

Site visit #2 took place April 9-10, 2013, about six months into the environmental monitoring. Environmental and energy monitors were read. Linden spent some time

analyzing the readings. The project team met to discuss findings, consider experimental operational changes that might improve the preservation quality of the monitored spaces, and consider how best to use the additional funds for improving the current system.

SC&UA was added during the 1994-95 expansion to Steely Library. AHU#1a was added then to service the new space. Design specifications required 23% of the air to come from the outside. During the winter, the exterior air is cold and dry. When mixed into the existing air in Special Collections, the resulting air is too dry for the archival collections. Despite working hard, the humidifier is only able to raise the relative humidity to 20%, still significantly shy of the desirable 30 % minimum. Because the return air coming back into the HVAC system from the second floor is hotter than the air returning from the first floor, it requires more energy to cool the air to the set point [the temperature it is supposed to be at when it leaves the system to go back out to all the rooms]. Linden suspected that the volume of air returning from the second floor was greater than from the first floor. If true, this factor would increase energy usage because the second floor air is so much hotter. Mixing in a large quantity of outside air in winter provides a cheap way to cool the air temperature. This method is comparable to a homeowner opening the window to cool off a hot interior. The problem for SC&UA is that the free cooling brings excessive dryness with it.

Another issue is that the cold water coming in to AHU#1a is part of the campus wide water supply cooled at the Power Plant. Under the present campus system configuration, it isn't possible to make the archives' portion of the water any cooler than what goes to the rest of campus. If AHU#1a was split off from the main system, a booster system could be added just to AHU#1a to further chill the arriving water enabling it to reach the preservation conditions desired for SC&UA.

On Linden's advice, the team decided to try a nightly system shutdown from 11 pm – 7 am seven days a week. Readings would determine whether changes in relative humidity and temperature remained in a safe range from a preservation perspective as summer arrived. Implementation was scheduled for April 29, 2013.

Based on analysis of six months' monitoring, the team considered three options for the use of the additional \$10,000: a balancing study measuring air flow throughout points in the mechanical system, dampers and sensors for the variable air valve [VAV] in the vault, and installation of manual dampers on the return air for both the first and second floors (to make the quantity of return air from each more equal).

The decision was to start with the balancing study. First, it would determine the percent of air returning into the mechanical system from the first and second floors respectively, possibly identifying an imbalance. Reduction of the quantity of hot second floor air might make it easier to achieve target environmental ranges for SC&UA and perhaps also reduce energy expenses. Second, the study would confirm whether the return air duct was large enough to maintain the system's balance if the volume of outside air were to

be reduced. Third, it would be used to determine whether the mechanical system was now functioning differently than its original 1994-95 design.

It was learned that summer renovation work on the plaza adjacent to Steely Library required shutting down the air handlers for the duration to cover them against debris. Unfortunately, the balancing study couldn't be conducted with the system shut down. The question of whether the return air flow ratio between the first and second floors could be adjusted was debated over the summer. There was concern that adjustments might change the building's air pressure, making it more difficult to open and shut the first floor exterior building doors in one direction or the other.

Site visit #3 took place Sept 18-19, 2013. All environmental PEM and energy monitors were read. Analysis of the energy monitor readings revealed that the nightly shutdown thought to have begun on April 29th had in fact not taken place. The system programming was reset to start this test again and has run continuously since Oct 15, 2013.

The question of reduction of outside air resurfaced. Hamill volunteered to estimate actual room usage/occupancy. Using this data, Foster would calculate the amount of outside air required based on occupancy then compare it with the amount of outside air per the 1994-95 design and per applicable present day codes. Once it was determined whether the amount of outside air was lower by occupancy or design rate, the question of an experiment at the lower rate could be discussed. The concern for air quality in office spaces during a reduction in outside air was raised, but anecdotally no concerns were heard about air quality during the system shutdown for the plaza project.

Regrettably the balancing study took place after this visit so although options were discussed, decisions were tabled until the study results were received and analyzed. Discussion centered on how best to apply the remaining funds to improve the system, whether to extend the grant by six months due to delays caused by the plaza work, and how best to use the extension time – continued experimentation to improve the existing system or redirect to do what we can to specify a new system? Team members committed to an additional six months for the balancing study and the outside air calculation. There was mixed receptivity for testing the system with a reduction in outside air.

The balancing study was conducted in late September, 2013 with results in mid-October. The study showed the system was functioning per design reasonably well; as hypothesized, more air was being returned to the HVAC system from the second floor than the first – approximately 60% to 40%; and that when set at the minimum, dampers let in 16.3% of outside air.

Subsequent discussion in late October moved more strongly towards doing what we could to create a separate HVAC system for the archives. This decision was based on a year of monitoring, information from the balancing study, and the awareness that some potential adjustments/improvements under consideration would only yield minimal

benefits. At this point it was clear that the team would be unable to complete its work by the scheduled deadline of Dec 31, 2013. In early November, Hamill requested a no cost six month extension from NEH that was approved.

Outside air required by occupancy was calculated at 16.7%, much less than the 23% based on design codes, and very close to the 16.3% recorded with dampers set at their minimum setting.

Hamill reviewed expenses to date and obtained cost estimates for work towards a new system design. She also discussed the shift in work under consideration her NEH Program Officer to determine whether it fell within the scope of the grant program and seemed appropriate based on the work that preceded it. After determining sufficient funds were available in the appropriate expense category and receiving authorization from her Program Officer, Hamill decided to use the remainder of the grant project to develop specifications for a new HVAC system that would provide a preservation environment for the archival collections.

Linden provided specifications for humidity and temperature ranges that would create a safe preservation environment for the archival collections. Staggs and Fisher Consulting Engineers, Inc. was hired to design a new HVAC system that would meet those ranges, producing a schematic drawing, narrative report with system specifications and a cost estimate.

Linden submitted his report summarizing his findings, reviewing the Staggs and Fisher engineering work from an archival preservation perspective and making his recommendations for future considerations, changes and capital improvements that would help create the sustainable preservation environment sought by NKU's Special Collections and University Archives.

Receipt of this grant was publicized on NEH's website, Steely Library's website, SC&UA posted publicity on its blog <http://nkuarchives.wordpress.com/2013/01/>, and NKU issued a press release. It was announced in the Society of American Archivists *Outlook* [national newsletter], Midwest Archivists *MAC Newsletter* [regional newsletter], *College & Research Libraries News* [national] in their Grants column, *Annotations* [a Steely Library publication for its friends, donors and supporters]. A subsequent column in *Annotations* updated progress after the second site visit.

Accomplishments

The first accomplishment was bringing together the collective expertise of NKU's University Archivist, the mechanical specialists who manage the HVAC system, upper level management from the University Architect's Office, the engineering firm that designed the system being studied and an archival preservation environment specialist from the world renown Image Permanence Institute to study the question of how to improve the archives' preservation environment. It is unlikely that this would have happened without the assistance of this NEH grant. The second was to balance these different perspectives enabling each to contribute without overshadowing the other. It is

not all that common for HVAC specialists, their managers, engineers and archivists to talk to one another. However, several operational changes were identified that look like they will improve or cause no harm to the archival collections while holding energy costs level or yielding as much as a 33% savings on the operation of AHU#1a.

We met our grant application goals: to study and evaluate the existing environment in SC&UA, performance of the existing mechanical system and operational practices for the system. We documented relative humidity and temperature readings for twenty-one months in offices, display cases, multiple locations in the collection storage room (checking for microenvironments and the impact of a long glass wall), in ducts bringing and returning air, and in all the phases of the mechanical system itself. We monitored energy usage for the same period.

The air balancing study helped us evaluate how the system functions nearly twenty years after its design and installation, which is pretty well. It confirmed suspicions about the ratio of return air flow from the first and second floor. If the ratio was reversed or more equal, less hot air would return to the air handler, potentially reducing its workload and the associated energy costs. It was theorized that if the system wasn't working so hard to meet the temperature set points, it might have done a better job of improving the humidity levels. The impact of this theoretical rebalance is unknown and not guaranteed. The concern about an imbalance in the building's air pressure stopped this line of study. Most helpful was the study's determination that when dampers regulating the amount of outside air added to the system were set at minimum, the outside airflow very closely matched needs based on current usage of the space.

On the operational side we learned how to implement nightly shutdowns; programming needs to be changed in several locations. By analyzing the resultant temperatures at the end of the nightly shutdown and how long the system took to return to the temperature just prior to each shutdown, it was determined that during fall, winter and spring the shutdowns were not harming the collections. Temperature readings during the summer peak have not yet been evaluated to determine whether the shutdowns need to be shortened at that time of year. This was one of the most beneficial findings of our study because it started producing cost savings without requiring any additional financial investment.

Despite losing Linden's expertise with the grant completion, due to the findings of the balancing study and our ability to set the dampers bringing in outside air almost exactly to the calculated amount of outside air, in mid-June, 2014 the dampers were set at their minimum thus reducing the outside air to 16.3%. The relative humidity and temperature readings need to be analyzed to determine possible impact, but there have been no anecdotal complaints of adverse impact to human comfort. The more significant question is whether the preservation quality of the environment in the collection storage room has improved. Longer term is the question of whether this setting is simply experimental, seasonal or more long term. It had been stipulated by HVAC managers that for energy consumption the outside air reduction couldn't take place until the outside air temperatures remained above 45°F even though the outside air had a

greater detrimental impact in winter because of the resulting dryness. This stipulation would prevent reduction of outside air in winter. The cost difference for energy consumption is unknown. Also unknown is whether the energy savings from nightly shutdowns would cover the cost of winter reduction of outside air [i.e. loss of free cold outside air to cool]. The outcome of this discussion is still to be determined.

After extended study of AHU#1a, the general conclusion was that not much more (beyond the cyclic shutdowns and the reduction in outside air) can be done to improve the humidity problems or the preservation environment in SC&UA with the existing system. Other changes were debated, but it was felt that the potential benefit was minor relative to the cost, labor, parts or construction that would be required to implement them and the outcome was not guaranteed.

As a result of this conclusion, the final accomplishment of this project was the completion of the schematic engineering drawings, narrative report with specifications and cost estimate for a separate HVAC system to serve the first floor space of Steely Library now served by AHU#1a, representing 25% of the engineering necessary to design/install the specified system. I am particularly pleased to have had this work also reviewed for its ability to create a sustainable long-term preservation environment. I think many engineers and architects are unfamiliar with the distinct needs of archives. If they engaged in preservation discussions with archivists before designing, we might see more appropriate systems from the beginning and less retrofitting. Print and digital (CAD) versions of the completed engineering are on file at the University Architect's Office, the University Archivist's office, the Associate Provost for Library Services' office and with other recipients of this grant's documents/reports. The delivery format was specified to enable any engineering firm to pick up with the project at a future date.

Although this may seem minor by comparison another accomplishment of this grant was education. As the Project Director I had the opportunity to learn how HVAC systems (or at least ours) function. IPI's recent research on the relationship between relative humidity and temperature, and their impact on collection preservation changed my understanding of what constitutes a desirable preservation environment. This represents a substantive change from prior archival literature on the subject. I have already shared this information in the 2012 book I authored and will continue to refer others to this new knowledge. Hopefully my teammates also learned about what constitutes an environmentally safe environment for archives as a result of our numerous discussions.

Audiences

Due to the nature of this grant's project, the immediate audience was the university's employees responsible for the care and preservation of the archival collections and the workmen and managers responsible for the mechanical equipment that helps provide the requisite preservation environment. Educational benefits were discussed above.

Secondary audiences include those readers of information disseminated about the project and those researchers who benefit from any lengthening of life for collections stored in this environment. Both of these are difficult to measure.

Evaluation

The project itself was not formally evaluated.

Under Accomplishments, I mentioned the challenge of bringing diverse perspectives together. Not everyone was equally receptive to experimenting with the mechanical system and some thought they already knew the solution to the problem from the start. However the majority was willing to respect the process and see what the data revealed. As the project director I reiterated the fact that we had agreed to experiment, and that we wanted measurable data about the system's operation and performance to support whatever conclusion was reached. I tried to respect concerns. My persistence was also an important factor. Despite some skepticism, we were able to identify several beneficial operational modifications.

The unexpected problem was billing difficulties between Northern Kentucky University and Rochester Institute of Technology, home of the Image Permanence Institute. At NKU, grant finances are regulated by the Comptroller's Office as well as Procurement. Billing for consultation fees also involved several offices at RIT. Based on IPI's proposal, I thought we would be billed for time worked at a daily rate. At least one financial person at RIT expected they would be paid the full amount allotted in the grant budget regardless. She felt it was simply a matter of what percent of the payment they would receive at what point. This difference of interpretation took a while to uncover, then was difficult to reconcile. Initial description of work being billed was minimal and confusing. It took ten months of discussion to produce a bill and documentation acceptable to NKU. Grant recipients need to be aware of the difference between these two contract interpretations so they can communicate their expectations clearly when making contracts and minimize surprises that could throw their budget off.

The university's decision to work on the plaza adjacent to the library was unforeseen and was not perceived to be problematic until shutdowns for the HVAC system were mentioned. So, a caution to allow for the unexpected, don't schedule your activities too tightly. Without an extension, we would not have made our deadline or not with as successful an outcome. Ask for an extension if it makes sense.

Continuation of the Project

Monthly reading of the environmental monitors started under this project will continue. The number and location of the PEM monitors has been reduced, but SC&UA will continue to be monitored post grant. The division supervisor on the second floor has asked for their monitor to also remain.

The cycle of nightly shutdowns will continue. Their duration may be modified pending analysis of the monthly PEM readings and seasonal variations. I hope to continue the

reduction in the amount of outside air used. This will depend upon the analysis of impact on the environmental readings and concerns about the impact on energy cost.

Long Term Impact

On a scale of Risk, OK, Good, [low to high], SC&UA generally falls in the OK category for premature aging of the collection materials. There are times when the relative humidity and temperature combination present the risk of silvering in black and white photographs [approximately 40% of the university photographer's pre-2000 images and a smaller number of historical photos], corrosion of metal firearms and munitions stored in the vault and mold growth for rare books, papers and photographs. This assessment indicates the need for changes to improve the preservation quality of the current environment for the collections.

Data findings identified two operational changes that would improve or cause no harm to collections while producing energy savings. However these changes are insufficient to fully offset the current risk to collections, and there is reluctance to apply the most beneficial change year round.

As a step towards a more impactful solution, through this NEH grant the project team was able to contract for and obtain engineering design schematics and specifications for a new, separate system to meet this need. Further, this engineering work was reviewed by a preservation environment specialist to evaluate the designed system's ability to produce the desired environment based on the most current scientific knowledge of relative humidity and temperature. This represents 25% of the anticipated engineering work for this project.

The data, findings, consultant's report and engineering products will be brought forward to the university's administration to argue for funding for the designed system. If they agree to funding, NKU will apply for an NEH SCHC Implementation grant to maximize the impact of the funds.

Receipt of this NEH grant was widely publicized from the local to national level. It has brought additional respect for Steely Library within the campus, among peer institutions in state and within the greater archival/library community. It has added to SC&UA's professional image within the community. This has potential beneficial implications as we work to acquire new collections and financial donations.

Working on this project has changed my understanding of what constitutes a preservation environment for archival collections. I will apply this new knowledge not only to the archives I manage, but I will also share it with others who manage or care for archival collections. I included this new information in *Archives for the Lay Person: a Guide to Managing Cultural Collections* published in December, 2012. I will explore other archival and library venues to disseminate this information through presentations or journal articles.

Twenty PEM monitors were used to collect data during this grant. I anticipate keeping about half. It is my intention to give the remainder to organizations in the area that could benefit from environmental monitoring of their collections, but may be unable to purchase a monitor. These organizations will be self-identified by their participation in an archival security workshop sponsored by NKU through a separate NEH grant or by personal knowledge of this archivist. In this way I hope that our learning will spread outward to other area organizations that look to Steely Library's archives because of its professional expertise.

Grant Products

Products from this grant include the engineering schematics and specifications, the Image Permanence Institute's consulting report, the air flow balancing study, and this final report which will serve also as a white paper.

Potential journal articles or conference presentations are under consideration. This final grant report, as well as the other grant products will be distributed to team members, offices at NKU including the Associate Provost for Library Services; the University Architect's Office; Research, Grants and Contracts; and the Comptroller's Office. Steely Library is currently developing an Institutional Repository. Once it is functioning and accepting documents, I will submit my grant report for inclusion.

Appendices

- Staggs & Fisher Consulting Engineers, Inc. – New Archives Air Handling Unit Narratives, Indexes and Estimate [narrative and drawings]
- Jeremy Linden, Image Permanence Institute, Rochester Institute of Technology – Sustainable Preservation Environment Planning Project [narrative report]
- Publicity